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TO: Dr. D. Mills
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INTERFERENCE WITH COMPUTER SCREEN DISPLAYS

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Observations of moving or "wiggling" computer screen displays have been reported in some locations within the Research Division complex. This effect is generally an indication of interference from a source of 60-Hz magnetic field in the vicinity. Possible approaches to alleviate the problem are discussed.

1. INTRODUCTION

With the proliferation of personal computers, both within Ontario Hydro and elsewhere, the possibility of experiencing electrical interference problems has steadily increased. One such problem occurs when a computer is located close to a source of 60-Hz magnetic field, and is characterized by a regular wavelike motion of the computer screen display that can be disconcerting to operators. Several reports of this "terminal illness" were received within a period of a few weeks, suggesting that a brief discussion of the problem and its cures might be appropriate.

2. THE INTERFERENCE PROBLEM

On all cathode ray tube (CRT) type computer display screens, the display is drawn by moving a narrow beam of electrons back and forth over a surface that converts some of the beam energy into light. The beam is generated in a fixed electron "gun" at the back of the tube and is deflected onto the appropriate screen location by two magnetic fields, one for the vertical direction and one for the horizontal direction. The vertical direction is scanned between 60 and 70 times per second. If an external magnetic field alternating at 60 times per second is added to the internal vertical deflection field, then the beam will appear to oscillate around its correct position at a rate corresponding to the difference between these two frequencies. The result is to impart a wavy motion to the display at a frequency from perhaps 1 cycle per second to 10 cycles per second.

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This problem was investigated by Electrical Research in 1986 and it was found that the movement could be seen when the external 60-Hz field reached a strength of about 10 mG or 1 μT /1/. A similar finding was reported in the IEEE transactions a year later /2/. This level of field can be found within a half to one metre of many electrical appliances, and close to electrical service conductors or water pipes in homes and other buildings.

Sixty-hertz magnetic fields greater than 1 μT can also be found on or close to transmission line rights of way, near electrical power distribution facilities and industrial equipment such as welders, around some test facilities in electrical research laboratories, or next to some types of office equipment.

3. THE SOLUTIONS

As with all interference problems, this problem can be tackled at the source, at the affected device, or at the pathway from one to the other. The simplest solution is to increase the distance between the computer screen and the source of the magnetic field; even a fraction of a metre may be sufficient if the source is small.

If sufficient separation cannot be obtained because of space or other limitations, then the source should be examined to see if a simple remedy can be applied at that end. The most common source in commercial or institutional buildings is the three-phase power bus that is used to feed various load centers within the building (see Appendix and Reference 3). In a typical feeder arrangement, three individually-sheathed or conduit-enclosed conductors are installed side by side in parallel runs. Some grounding arrangements allow currents to flow in the sheaths or conduits that are not balanced by the load currents.

Magnetic fields from these feeders can be reduced by eliminating unbalanced sheath or conduit currents on individual-core cables, and by reducing the separation between the core conductors. Where two or more conductors for each phase run parallel to each other, then a reduction may be achieved by selecting a more favourable phase arrangement. Appropriately placed phase transpositions may also be used in certain circumstances. Cables that contain the three conductors within a single sheath generally produce lower fields than individually-sheathed cables.

Notwithstanding the above, feeder installations must comply with the applicable electrical code.

Moving on to more exotic solutions, it is of course possible to redesign the display unit in order to reduce the sensitivity to external fields. However, this is difficult and not recommended except on a production basis. Empirical observation suggests that some units may be more sensitive than others but little, if any, quantitative information is available.

The use of shielding placed between the source and the affected device is sometimes suggested. Unfortunately, effective shielding of 60-Hz magnetic fields requires either a rather large amount of iron or steel, or specially fabricated high-permeability materials, and is generally not considered to be practical. Further research would be helpful in identifying situations where shielding could be used as a practical solution to low-frequency magnetic interference problems.

If all else fails, bucking coils may be used in a servo-loop arrangement to generate a magnetic field that cancels the source field in the vicinity of the affected device. This is a relatively costly engineered solution that must be tailored to the specific site.

4. CONCLUSIONS

The video displays on computer screens are subject to interference from 60-Hz magnetic fields. The interference takes the form of a wavy motion of the display that becomes apparent at field levels of about 1 μT and that can be annoying to the operator.

Shielding or redesign of the display unit is possible, but not generally practical. The preferred solution is to move the unit away from the source. If the source is small or well localized, a move of only a metre or less may be required.

The most common source of troublesome 60-Hz magnetic fields in commercial or institutional buildings appears to be the three-phase feeder. Feeder design is not generally optimized to minimize the generation of magnetic fields. Where a feeder-related interference problem cannot be solved by moving the display unit, the feeder should be examined to see if corrective measures can be applied to reduce the field at source.

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REFERENCES

1. Memo to S. Sax, March 10, 1986.

2. IEEE Transactions on Power Delivery, April, 1987, pp 558-63.

3. Journal of the Institution of Electrical Engineers 67, 1929, pp 359-437.

APPENDIX

Magnetic fields due to load currents on 3-phase feeders (from Reference 3).

The magnitude of the magnetic field produced by load and sheath currents on a 3-phase feeder can be calculated from standard formulas.

As an example, consider the planar conductor arrangement shown in Figure A1. For distances large compared to the conductor spacing but short compared to the length of the feeder, the field due to a balanced load current I_L in each conductor is given by:

$$|B_L| = \frac{\sqrt{3}}{5} \frac{S}{r^2} I_L (\mu T) ,$$

and the field due to a net sheath current I_S is given by:

$$|B_S| = \frac{1}{5} \frac{I_S}{r} (\mu T) .$$

Consider a 3-phase feeder with a conductor separation of 10 cm, a load current of 100 A, and a net sheath current of 10A. The resultant magnetic fields will vary with distance as shown in Table A1.

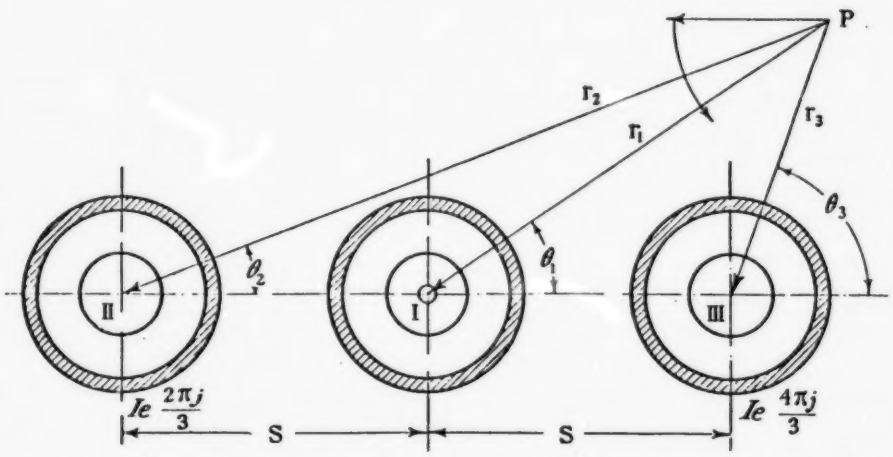

Figure A1

TABLE A1

r(m)	$\|B_L\|$	$\|B_S\|$	$\|B_{TOT}\|$ (μT)
0.5	13.8	4.0	9.8 - 17.8
1.0	3.5	2.0	1.5 - 5.5
1.5	1.5	1.3	0.2 - 2.8
2.0	0.9	1.0	0.1 - 1.9
2.5	0.6	0.8	0.2 - 1.4
3.0	0.4	0.7	0.3 - 1.1